

SPINAL CORD MEDICINE

HANDBOOK FOR PATIENT AND FAMILY



Lung Care



Frazier Rehab Institute

A service of Jewish Hospital & St. Mary's HealthCare

**Frazier Rehab and
Neuroscience Center
220 Abraham Flexner Way
Louisville, Kentucky
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(866) 540-7719 (Toll Free)

(502) 582-7495

www.spinalcordmedicine.com

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THE PATIENT AND FAMILY HANDBOOK

This Handbook is designed to give you the information to better understand spinal cord injury and the tools needed to manage your health care needs successfully. Information is intended for you and your family because, those who love you, will often be involved in assisting you with your care needs while in the hospital, and in the home environment. As you read through the Handbook, your rehab team at Frazier is available to address your questions and provide you more information pertinent to your needs.

HANDBOOK CONTRIBUTORS

Contributors to the development of the Patient and Family Handbook

Roger Butterbaugh, Ph.D.
Peggy Cox, RRT
Belinda Coyle, RN, BSN, CRRN
Jill Farmer, CTRS
Janet Gowen, RN, MSN, CRRN
Marge Hetrick, RD, LD
Krista Kinzer, DPT
Karey McDowell, MS, CTRS
Lauren Metzmeier, OTR/L
Kathy Panther, MS, CCC-SLP
Reena Sharma, OTR/L
Shelley Siebert, PT, MP
Douglas Stevens, M.D.
David Watkins, M.D.
Shellie Weston, OTR/L
Victor Wood, RN, CRRN

A BRIEF NOTE ABOUT THE FOUNDER OF FRAZIER REHAB INSTITUTE

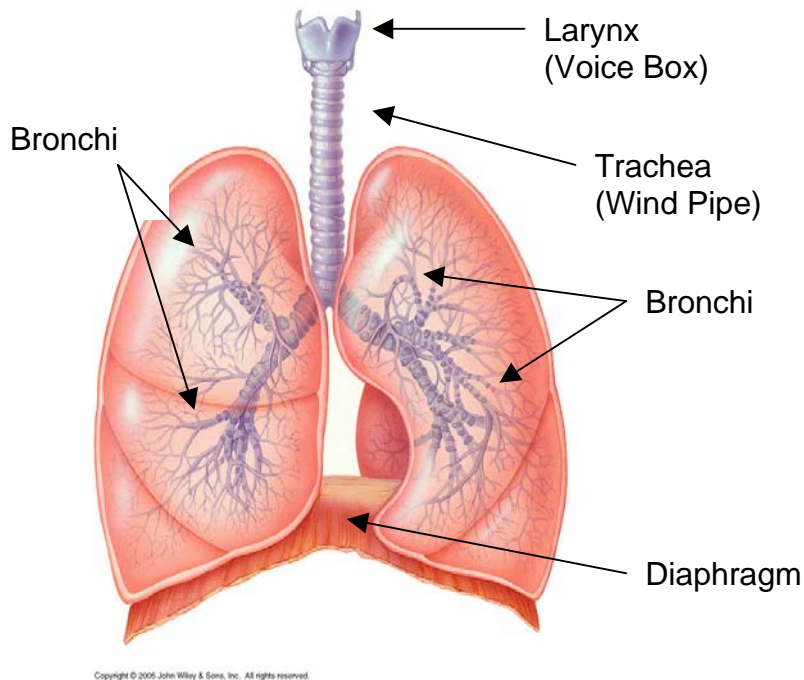
In her early 20's, Amelia Brown of Louisville sustained a spinal injury in a car accident in the 1940's. With no rehabilitation services in Louisville, she traveled to New York for treatment. After returning to Louisville, she married a physician, Dr. Harry Frazier. Believing Louisville needed its own rehabilitation facility, Mrs. Frazier founded the Frazier Institute of Physical Medicine and Rehabilitation in the early 1950s. Her son, Owsley Brown Frazier, served as Chairman of the Fund Raising Committee for Frazier's new building, named the Frazier Rehab and Neuroscience Center, which opened in 2006.

DISCLAIMER

The information contained herein is intended to be used in accordance with the treatment plan prescribed by your physician and with the prior approval of your physician. You should not begin using any of the methods described in this publication until you have consulted your physician. Jewish Hospital & St. Mary's HealthCare, Inc. D.B.A. Frazier Rehab Institute, its affiliates, associates, successors and assigns, as well as its trustees, officers, directors, agents and employees are not liable for any damages resulting from the use of this publication.

NOTE: Words *italicized* in the text below are defined in the Glossary at the end of this Chapter.

LUNG CARE



Spinal cord injury and impairment may make it more difficult to breathe air in and out, cough and keep your lungs healthy and free of infection. How well your lungs work after injury will be influenced by the level of your injury. Your recovery will also be affected if you were a smoker, have been exposed to environmental intoxicants or had asthma or other lung diseases.

NORMAL ANATOMY AND PHYSIOLOGY

The Respiratory system includes the nose, trachea and lungs. The respiratory cycle of inhalation (breathing in) and exhalation (breathing out) occurs at a rate of 12 to 16 times per minute.

The nose and mouth warm, filter and humidify the air you breathe. The air breathed in goes through the voice box (*larynx*) into the windpipe (*trachea*), and then through the air passages (*bronchi*) leading to the air sacs (*alveoli*). It is in the air sacs that oxygen enters the blood stream and carbon dioxide leaves the blood stream as you exhale. Oxygen is needed for all cells in your body to work. Carbon dioxide is a waste product.

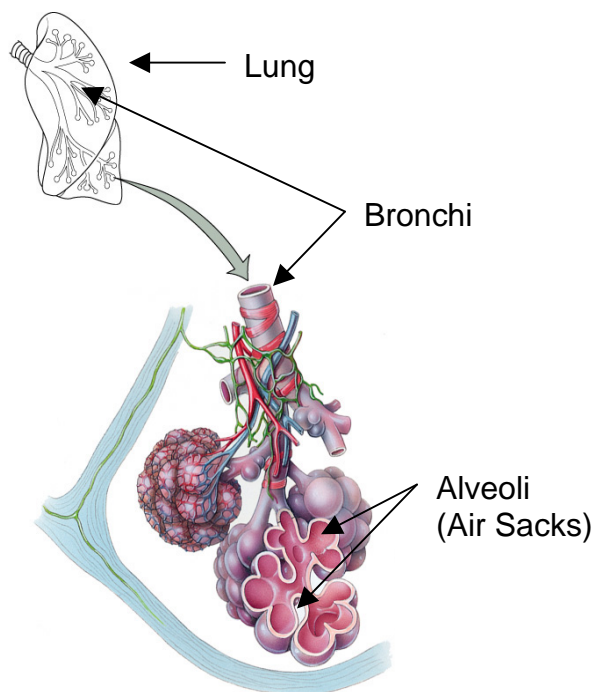
The windpipe (*trachea*) and air passages (*bronchi*) are simple passageways by which the oxygen you breathe gets into the air sacs. Located in these passageways are tiny hair like structures (*cilia*) and mucus (*phlegm*) that help clean the lungs of the dirt and pollution in the air you breathe. It is important to keep this mucus thin in order for the cilia to remove the dirt and

clear secretions (*mucus*) from the lungs.

These air passages and air sacs together make up the lung. See illustration on next page. The right side of the lung has three lobes and the left side of the lung has two lobes. The heart sits between the lungs. After the blood picks up oxygen in the lungs and gets rid of the carbon dioxide, the blood goes to the heart where it is pumped to all parts of the body.

Your lungs are surrounded by the rib cage and muscles. The major muscle that moves air in and out of the lungs is called the *diaphragm*. Other muscles which help the diaphragm are the chest muscles, neck,

and shoulder muscles, and abdominal muscles. Moving air in and out of the lungs is like a bellows:



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nerves that serve the breathing muscles. The brain sends signals to inhale and to exhale 24 hours a day. The brain also monitors oxygen and carbon dioxide levels in the blood and sends messages to the muscles via these nerve routes to tell the muscles to speed up and breathe more deeply or slow down and breathe more shallow.

PATHOLOGY

Injury to the spinal cord can weaken or paralyze some or all of the muscles needed for you to breathe on your own. How well you breathe is affected by the condition of your lungs before injury and by the level and extent of your injury. Breathing complications may occur for the following reasons:

- During inspiration, the muscles contract and make the chest cage larger and air is pulled into the lungs. The diaphragm and chest muscles do most of the work. The neck and shoulder muscles also help.
- During expiration, the muscles relax and air flows out of the lungs. Expiration is usually passive as muscles relax. However, during forceful exhalation, as in a cough, the diaphragm and the abdominal muscles are active.

All breathing muscles are controlled by the brain which sends and receives messages from the spinal cord which in turn is connected to individual

- The loss of abdominal and chest wall muscles may reduce your ability to cough and clear secretions.
- If secretions remain in the airways and air sacs, the oxygen cannot get into the air sacs.
- A weak diaphragm can also fatigue or tire out easily.
- Without your breathing muscles moving properly, the tiny air sacs, called alveoli, may collapse.
- Injury may cause the chest muscles and the diaphragm to work against each other resulting in inefficient work.

The end result of muscle paralysis is: change in rate, depth and rhythm of respirations (breathing); impaired removal of secretions; and abnormal oxygen and carbon dioxide levels in the blood.

LEVEL OF INJURY AND RESPIRATORY FUNCTION

The level and extent of your spinal cord injury or impairment will determine how well your respiratory system will function.

S₅ through L₁. If you have a complete spinal cord injury between S₅ and L₁, your breathing muscles will not be affected and you will have the ability to breath as you did before the injury.

T₁₂ through T₆ Level of Injury. If you have a complete spinal cord injury between T₁₂ and T₆:

- The abdominal muscles will be weakened or paralyzed.
- Your ability to cough will be impaired.
- Alternative or *augmented cough* techniques will be needed.

T₅ through C₅ Level of Injury. If you have a complete spinal cord injury between T₅ and C₅:

- The abdominal muscles will be paralyzed and varying levels of chest muscle function will be lost.
- The ability to take a deep breath independently and to cough will be lost.
- Deep breathing techniques will be needed to prevent air sac collapse.
- You will need to learn alternative and augmented cough techniques.

C₄ Level of Injury. If you have a complete spinal cord injury at the C₄ level:

- All breathing muscles except the diaphragm will be paralyzed.
- Normal respiratory pattern may be reversed.
- The ability to take a deep breath and to cough independently will be lost.

- Deep breathing techniques will be needed to prevent air sac collapse.
- You will need to learn alternative and augmented cough techniques.
- A *tracheostomy* may be needed to allow secretions to be suctioned with a catheter.

C₃ Level of Injury. If you have a complete spinal cord injury at the C₃ level, all items listed under Levels of Injury above apply here. In addition:

- There may be one-sided or two-sided impairment or paralysis to the diaphragm.
- The ability to take a deep breath with alternative techniques may be lost.
- Mechanical ventilator, sometimes called a *respirator*, may be needed to assist with breathing.

C₂ and C₁ Level of Injury. If you have a complete spinal cord injury at the C₂ or C₁ level, all items listed under Levels of Injury above apply. In addition:

- All respiratory muscle function will be lost; all breathing muscles are paralyzed.
- Full time mechanical ventilation or respirator will be required.
- Tracheostomy to remove secretions will be required.

If you have an incomplete spinal cord injury, the descriptions above may or may not be accurate to your situation. Your respiratory therapist and others on the rehab team will help you understand how your injury has affected your ability to breathe and how best to keep your lungs healthy and breathing muscles strong.

Oxygen Deliver Systems. Immediately after injury, it is common to need additional oxygen to raise the level of oxygen in your blood. One common method is to deliver oxygen through a tube or nasal prong directly into the nose. If needed, a mask with a bag may be used to provide higher concentrations of oxygen. If you have a tracheostomy, oxygen may be given to you with a special trach -mask or T piece connector. In the event that a mechanical ventilator is used, oxygen is then delivered by the machine.

Ventilator – Respirator. You may require temporary ventilator assistance while your body heals. However, when spinal cord injury results in paralysis of the diaphragm, a ventilator may be needed on a permanent basis. If so, your rehab team will educate you and your family about how to manage a ventilator in the home setting.

DIAGNOSTIC TESTING

Your doctor and respiratory therapists may use several methods to fully assess your respiratory function. Many of these tests can be done bedside.

For example:

- Direct observation and listening to the movement of air in your chest.
- Chest X-rays.
- Bronchoscopy done by looking into your air passages with a special scope.
- Electrical muscle testing.
- Arterial blood tests to measure oxygen and carbon dioxide levels.
- Pulmonary function tests and oximetry testing measures oxygen in the blood performed with a finger sensor.

PULMONARY HYGIENE

Pulmonary hygiene refers to the removal of secretions needed to maintain your lungs' ability to get air into and out of air sacs. Many patients need a combination of daily treatments for successful maintenance. These treatments may include use of a *manual resuscitator*, saline instillation, humidification and respiratory muscle training. Secondly, to maintain opened air passages (bronchi), you may require nebulized medications which are inhaled either through your mouth or tracheostomy tube. Other treatments, described in details below, include positioning, positive pressure, coughing, postural drainage, percussion and vibration.

Positioning. Frequent changes in position prevent the pooling of secretions in the lungs. You should turn or be turned at least every two hours while in bed. Position changes while out of bed can be done through use of the reclining mechanism on some wheelchairs, lean-overs, or wheelchair pushups.

Positive Pressure. On occasion, positive pressure is used to inflate the lungs periodically either by a manual resuscitator (ambu bag) or with a special machine. Treatments are usually three or four times a day.

Coughing. Coughing is an automatic reflex that causes air to be forcefully expelled from the lungs to rid the lungs of secretions and foreign substances. In order for a cough to be effective, muscles of the chest, abdomen and the diaphragm need to work in perfect harmony. This very important cleaning mechanism of the lungs is often impaired after spinal cord injury. When some of these muscles are weakened or paralyzed, certain techniques must be used to improve the cough.

These techniques include assistive (quad) coughing, the cascade cough, huff cough, end expiratory cough and sustained maximal inspiration as described below. In addition to effective coughing, other things need to be done to keep the lungs clear. Drinking the proper amount of fluids will make the mucus in the lungs thin and easier to cough up. Frequent turning and re-positioning will also assist in removing mucus from the lungs. Medications may also be used in improving airway clearance.

Augmented (Quad) Cough

- When your abdominal muscles are paralyzed, your caregiver's hand is

placed on the upper abdomen, two or three fingers below the center of the rib cage, while the other hand is placed on your shoulder. Take a slow deep breath and cough. As you cough, your caregiver abruptly pushes the abdomen in and upward.

- When your abdominal muscles are weak or fatigue easily, have your caregiver place his or her hands on your outer chest, maintaining contact during inspiration. As you cough, the chest wall is abruptly compressed without losing hand contact.

Cascade Cough

- Take a deep, slow breath.
- Cough successfully three or four times on same inhalation.
- Inhale slowly and repeat.

Huff Cough

- Same as above, except say “*huff*” while coughing. Instead of a cough noise, there is a huff noise.
- Especially good if you gag when coughing.
- May need to be followed with cascade cough.

End Expiratory Cough

- Take several deep inhalations (slow).
- On the third or fourth breath exhale half your air, then cough.
- Follow with cascade cough.

Postural Draining/Percussion and Vibration. If coughing alone is ineffective in keeping your lungs clear of mucus, a technique called *postural drainage* may be used. Just as the name implies, postural drainage helps different sections of your lung drain by changing posture or position. This usually means turning onto sides, back, and, if possible, the stomach. The positions used will depend upon which area of the lung requires drainage. This technique allows gravity to move the mucus into the airway where it is more easily coughed out. Your nurse or therapist will instruct you as to which position or positions will help drain your lungs.

Frequently, percussion and vibration are added to postural drainage. This combination is referred to as the ketchup bottle technique. When pouring ketchup out of a bottle, you turn it over (postural drainage), if it doesn't come out you pound the end of the bottle (percussion) and shake it (vibration). Just like with the ketchup bottle, these techniques help to move mucus from the smaller to larger airways, where it is more easily coughed out.

Percussion is also called cupping. This is done by cupping the hands and gently but firmly striking the chest in a rapid rhythmical fashion. The area to be percussed will be shown to you by your nurse or therapist. This should create a hollow not slapping sound if done correctly. A thin towel or sheet should be used next to the skin.

Percussion may be followed by vibration. This is done with flat, not cupped, hands on the chest. The arms of the person administering the treatment are locked. As the patient, you are instructed to take a deep breath and breathe out slowly. As you exhale, hands are placed over the appropriate area and a vibration is generated from the shoulder and upper arm. This should create a fine vibration on your chest wall which is also being compressed during the entire exhalation. This technique is repeated at least 3 times followed by coughing.

A mechanical precursor may also be used in place of this manual technique. Several methods may be tried and the one that yields the best results for you will be continued. It's important to remember that controlled coughing should follow each treatment. Sometimes, the cough may not be productive for an hour or two after the session.

RESPIRATORY MUSCLE TRAINING

Since spinal cord injury may paralyze or impair some of your muscles used for breathing, it is important to strengthen the existing muscles so they can take over some of the lost function. Your rehab team will show you various exercises to help you strengthen the working muscles that you have. In addition, your respiratory therapist may have you do additional exercises.

Breath Stacking/Incentive Spirometer. Breath stacking is a technique where you take three deep breaths in and hold the air for three seconds and exhale slowly. Some people prefer to use an Incentive Spirometer, a device to help with deep breathing. You should perform deep breathing exercises at least 80 to 100 times per day. This prevents some of the small air sacs in your lungs from collapsing.

Breathing Retraining. The Threshold Inspiratory Muscle Trainer and Therapep Expiratory Muscle Trainer are devices that consist of a spring-loaded valve, mouth piece, and nose clip. They are used to increase the strength and endurance of your respiratory muscles by conditioning. Just as walking and jogging increase the strength and endurance of certain muscle groups, these muscle trainers strengthen the respiratory muscles. This is done by placing a constant workload on these muscles during inspiration or expiration. The actual amount of resistance and length of time used will be prescribed by one of your team members. As your muscles get stronger, the workload and time will be increased. These exercises need to be done faithfully, and ideally, at the same time each day. The goal is 15 minutes, twice a day.

Diaphragmatic Weights. The diaphragm is a large muscle that is located under your lungs and in normal conditions performs about 60% - 80% of the work associated with breathing. When the spinal cord is injured, some of the chest and abdominal muscles may be paralyzed. When this happens, it is important to make the most of the diaphragm because it may be doing all the work of breathing. To do this, weights may be placed over the diaphragm, which is located just under the ribs and above the belly button. During inspiration, you should see the weight rise, and with expiration, it will fall. The amount of time and weight needed will be recommended by your therapist. It will be increased as your muscles gain strength. This is another form of conditioning exercise which needs to be done regularly.

RESPIRATORY CARE

Tracheostomy. A *tracheostomy* is an opening in the windpipe (trachea) into which a metal or plastic tube is placed to allow management of the airway. This may be required for several reasons in the spinal cord injured patient.

- When ventilator support, a respirator, is needed due to weakened or paralyzed respiratory muscles, the tracheostomy allows air to flow from the ventilator to the patient's airway and lungs by-passing the nose or mouth.
- A tracheostomy may also be required if coughing is ineffective and secretions accumulate in the lungs causing poor gas exchange and infection.

There are two basic types of tracheostomy tubes, cuffed and uncuffed. A cuffed tube is used when a closed system is needed, such as when a patient is on a ventilator or when a patient has swallowing difficulties and food or secretions enter the lungs by mistake. Extra care needs to be taken with a cuffed tracheostomy tube because the potential exists for the inflated cuff to cause too much pressure on the lining of the airway. Your nurse or therapist will instruct you on how to inflate and deflate the cuff and watch for potential problems. An uncuffed tracheostomy tube is used if the patient's primary problem is secretion removal.

Communicating with a Tracheostomy Tube. When a trach tube is in place, your ability to talk will be affected but various methods will be provided to help you communicate. From the beginning you may communicate through lip reading or writing. If the trach tube is cuffless, you may be instructed to simply place your finger over the opening during exhalation to speak. With a trach tube plugged, you can exhale air around the tube, up through your vocal cords (voice box) and speak. Often trach tubes are reduced to the smallest size needed and plugged.

Passy Muir Speaking Valve. In the event that the tube cannot be plugged or a cuffed tube is needed for mechanical ventilation, a special valve is used to help you to speak. The Passy Muir Speaking valve allows you to inhale through the trach tube but allows you to exhale through your normal voice box and upper airway.

The rehab staff will instruct you in the proper use of this valve. You must remember to:

- Deflate cuff prior to using valve if trach tube has a cuff.
- Clean valve daily with liquid ivory soap, rinse well and air dry.
- Discard when valve no longer functions or at least every other month.

Talking Tracheostomy Tubes. If you are ventilator dependent, various trach tubes are available which permit you to have the cuff inflated while providing a way to speak. An additional port, along with a secondary air flow source, shunts air above the cuff through your vocal cords, thus allowing you to speak. The ports on this cuff must be kept open to allow air to flow. This is done through irrigating the ports with saline every 1-2 hours.

WARNING SIGNS OF RESPIRATORY PROBLEMS

- Changes in sputum color, amount or consistency
- Fever greater than 38.3° C (100° F)
- Signs of dehydration (sticky sputum, dry tongue, dry skin, dark urine)
- Unusual fatigue
- Shortness of breath
- Behavior changes, difficult to arouse
- Headaches, confusion
- Decrease in pulmonary functions (vital capacity) or deep breathing ability.

Many of these changes will need treatment and help from your doctor. For example, if the sputum is yellow, then antibiotics may be ordered. Further diagnostic tests may be ordered such as a chest X-ray or arterial blood gases. Preventing respiratory infections is important. You should obtain both the pneumonia and flu vaccines. If you smoke, you should make efforts to stop smoking. It is important for you to monitor and be aware of all aspects of your respiratory system and ask for help when needed.

REFERENCES AND RESOURCES

<http://health.yahoo.com/ency/healthwise/ug2580/ug2927> - Lung care

GLOSSARY

ALVEOLI - Air sacks in the lung where oxygen enters the blood and waste products leave the blood.

AUGMENTED COUGH - Technique for coughing which improves cough or makes the cough more effective.

BRONCHI - Air passages in the lungs that lead to the small alveoli.

CILIA - Hair like structures in the bronchi that move in a wave like fashion to remove pollutants from the lungs.

DIAPHRAGM - Large breathing muscle attached to the bottom of the lungs and helps pull air into the lungs.

INCENTIVE SPIROMETER - Device used to encourage deep breathing.

LARYNX - Voice Box.

MANUAL RESUSCITATOR - Device which allows increased amount of air or oxygen to be given to lungs.

MUCUS -- Viscid fluid secreted by the mucous membranes and glands.

PASSY MUIR SPEAKING VALVE - Valve placed at the end of a tracheostomy tube that allows a person to speak and be heard.

PHLEGM - Thick mucus.

POSTURAL DRAINING - To help drain the lungs, the patient is placed in a specific posture (head below feet while lying in bed).

QUAD COUGHING - A cough that is assisted by pressing down and up on upper abdominal muscles to increase the productiveness of the cough. Often helpful with persons with quadriplegia or tetraplegia who cannot cough on their own.

RESPIRTOR - Breathing machine.

THRESHOLD INSPIRATORY MUSCLE TRAINER - Spring loaded device used to work expiratory muscles to improve coughing.

TRACHEA - Wind pipe carrying air to and from the lungs.

TRACHEOSTOMY - Opening in the throat, through trachea which allows a tube to be inserted.